PATENT SPECIFICATION

244,203

Application Date: May 22, 1917. No. 7345/17.

Accepted: June 7, 1917 (but withheld from Publication under Section 30 of Patents and Designs Acts, 1907 and 1919).

Authorised to be Published: Nov. 17, 1925. Date of Publication: Jan. 14, 1926.

COMPLETE SPECIFICATION.

Apparatus for Operation of Switches by Means of Signals.

I, Archibald Montgomery Low, of the Royal Flying Corps Experimental Works, Feltham, Middlesex, Captain in His Majesty's Army, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has relation to means for selectively operating a switch so that an electric current can be made to pass through a particular and selected piece of appparatus to the exclusion of others, the switch being controlled from a distance by signals which vary only in duration or number or periodicity or any of these together. It is a primary object of my invention not only to obtain the selective closing of a particular operative circuit to the exclusion of others, but also to render interference by extraneous signals or impulses difficult or improbable.

My apparatus may be operated by means of signals sent over a wire, but it is primarily intended for use by radio-telegraphy. It has been frequently proposed that different signals might be made at a distance by means of wireless radiation, by tuning receivers associated with these different circuits to different wave lengths so that any one circuit can only be operated by sending on a particular wave length. It has also been suggested that such signals should be used in combination to prevent interference, but these systems have two great disadvantages. In the first place the signals transmitted must be more or less continuous, and they are therefore easy to pick up, measure and block and they interfere with other wireless stations. Secondly, it is not possible to get such delicate tuning as to operate many different contacts with any certainty, and without using very heavy, costly and delicate apparatus.

In the present invention by means of a combination of so called tuning, synchronism and key signals it is possible to obtain the wireless operation of a number of instruments without any reasonable possibility of interference, and by means of a simple, small and light apparatus.

It will be evident from the following description of the apparatus that a considerable number of alterations may be made without departing from the principle of operation.

By way of introduction I will briefly indicate the nature of the incoming signals to which this apparatus is adapted to respond so as to effect the selective closing of a particular circuit, as this will enable the subsequent description of the working of the apparatus to be more clearly understood.

The incoming signal may conveniently consist of a series of one, two, three, four or more impulses of appreciable duration separated by spaces of pre-arranged duration, which may be uniform or otherwise. It is obvious that such signals can most conveniently be sent by a transmitting device of automatic character. As an example of a signal that might be employed when the receiving apparatus is adapted to work at fairly high speed I may take the case of four successive wireless impulses, each enduring for say $^1/_{12}$th of a second, and separated by spaces each of the same duration. If a particular operative circuit is adapted to be closed by such a signal it is easy to secure that it shall not be closed by a smaller or by a greater number of impulses, or even by a series of the correct number of impulses, (in this case four), if the total

[~~Price 1/-~~]

Price 3s. 8d.

duration of an impulse plus the space that follows it differs substantially from the prearranged duration (in this case $^1/_6$th of a second). It is not however necessary that the spacing between the impulses should be uniform, and a prearranged inequality of spacing may constitute one of the selective characteristics of the signal.

The cancelling or "work-out" signal which breaks the selective operative circuit and returns the switch to the normal or receptive condition consists conveniently of a single prolonged impulse, the duration of which may be uniform for all the operative circuits but must be sufficient (say $1^1/_2$ seconds) to enable a sluggish electromagnet to be effectively energized. A signal of less duration than this will fail to bring about release.

The apparatus which I will now proceed to describe is one of a very large number that have been constructed by me, and has been successful in prolonged experimental trials.

In the accompanying drawings Fig. 1 is a plan, Fig. 2 a side elevation, and Fig. 3 an end elevation. Figs. 4, 5 and 6 are details to an enlarged scale. Fig. 7 is a diagram of the circuit connections.

Referring to the drawings, 1 is a coherer which is so constructed that the particles or contact-making material is capable of holding a small charge. This may conveniently be done by enclosing the metallic filings in an exhausted receptacle containing a small quantity of bisulphide of carbon, or by using filings which have been coated with sulphur by passing sulphur dioxide in the form of gas over them.

The coherer controls a relay 2 the resistance of which approximates to that of the coherer. This relay is so arranged that while it is unaffected by ordinary vibration the period of its spring enables it to operate in rapid unison with incoming impulses should such be necessary. The relay and the coherer although preferably designed with special regard to the above qualities can be made to work well even if of reasonably ordinary construction. A tapper decoherer 3 restores the filings to the non conducting state in the usual manner when its electromagnet is energized.

A relay 4 controlled by the relay 2 is known as the main relay and has a pivoted armature to which current is supplied through spring-pressed rubbing contacts 15^b which serve to introduce a certain lag into the motion of the armature. A further lag on the closing of the main relay contacts 15 is provided by the spring 15^a and limiting stops 15^c.

The relay armature also bears a knife-edge member 9 which co-operates with three arms 10 extending from a disc 6 to constitute a kind of escapement. It will be observed that the limiting stop 15^c for the spring 15^a not only introduces a determinate lag in closing the tungsten contacts 15, but also pulls off the contact spring 15^a on the release of the armature and prevents the contacts from sticking.

The disc 6 is revolved through a slipping clutch by means of the shaft 14, to which motion is communicated from the motor 7 through the gear box 20. The motor 7 is driven from external batteries, the supply current passing through a lamp 8, Fig. 1.

It will be noticed therefore that every time the main relay 4 is energized, the knife-edge 9 allows one of the three arms 10 to slip past it, and the disc 6 makes one third of a revolution. The arm 10 in its motion slips over a contact 11 and makes a continuous contact of definite duration, which in practice is about 0.25 seconds; this contact operates the decoherer tapper. The timing of the motion of the arms 10 will be such that they come to rest just before the completion of the space interval that follows the signalling impulse that gave rise to their release and motion.

It is important to note that every contact in the apparatus is rendered sparkless by a condenser in the known manner, and that all connecting leads are situated and arranged in such a manner that inductive action is not set up. This is to prevent external sparks, magnetism or induced currents from operating any part of the gear unintentionally. The wave length most suitable to operate the apparatus is put at a different value from the oscillations produced by any local sparks or by the spark of a magneto on any neighbouring engine, should the apparatus be situated in an aeroplane for example.

The mechanism mounted on the base plate 12 is referred to as the "pecker gear". It will be the simplest method of description if I state the sequence of operation of the parts and then point out some of their functions.

In the present case it will be assumed that there are six operative circuits any one of which may be selected according to the nature of the incoming impulses. These six circuits are wired to six contacts on the fixed sector 13^a. The selection of a particular circuit is effected by bringing a brush 24 on a shaft which also bears the ratchet or escapement wheel 21 on to the contact to which that particular circuit is wired. By this means a battery may be caused for example to light a particular lamp or operate some other piece of electrical mechanism.

When the coherer is brought into the conducting state by an incoming impulse it will operate through the coherer relay, the main relay 4: when this relay circuit closes, the shaft 14 which drives the disc 6 by friction coupling is being revolved continuously at a known speed by the motor 7 through the worm gearing 20, so that as the main relay 4 operates, one of the arms 10 will slip past the knife edge of the relay armature, making contact at 11 and decohering the coherer ready for another signal. Moreover the preparation of the coherer for the next signal has due relation to the frequency or time period of the signals to which the apparatus is to respond, as the decoherence is effected and maintained at a prearranged moment and for a prearranged period, depending as it does on the movements of the arm 10 which is driven at a speed determined by the motor 7 and reducing gearing.

The main relay contact 15 Fig. 7 is in circuit with magnets 16 via the commutator 17 and brushes 18, with a battery in series. The commutator 17 is shown developed in Fig. 5. It will be seen that it comprises two contact segments 17^a, 17^b of unequal length, with short insulating segments 17^c. The function of the commutator is to connect the relay contact 15 with the magnet 16 during the period while the incoming signals are being received, and subsequently to connect it with the sluggish release magnet 27 so that the prolonged release signal already referred to may energize that magnet. This function of the commutator will be more clearly explained below.

The commutator 17 is loose upon the shaft that bears the brush 24 and ratchet wheel 21. It is in rigid connection with an arm 31, and the commutator and arm are driven by a slipping clutch from the toothed wheel 14^a which receives motion from the constantly driven shaft 14. When the first impulse of an incoming series brings about the energizing of the main relay, the circuit of the magnet 16 will be closed for a brief period. This effects two results. In the first place, the attraction of the armature 16, Fig. 6, pivoted at 16^a operates the arm 22 and pawl 23 to pull round the ratchet wheel 21 through one tooth, thereby bringing the brush 24 on to the first of the selecting contacts on the segment 13. The ratchet wheel is provided with a detent pawl, and is rotated against the tension of a coiled spring which tends to return it to the zero position.

In the second place, the effect of energizing the magnet 16 is to release the commutator 17 and arm 31 by means of a release pin 26^a on the arm 22 co-operating with a pin 26, Fig. 4, on the commutator. The commutator and arm then slowly rotate under the frictioned drive imparted to them from the wheel 14^a.

The speed of rotation of the commutator is such that the maximum number of six impulses can be received while the brushes are passing over the segment 17^a.

When the commutator has completed about three fourths of its revolution (by which time all the selecting impulses will have been received, and will have successively operated the magnet 16) the brushes will have passed on to the segment 17^b. The effect of this is to cut out the magnet 16 and bring the release magnet 27 under the control of the main relay 4. The arm 31 is then brought to rest in a position in which it presses together two contact springs in the common supply circuit of the six selectable operative circuits wired to the sector 13. The commutator 17 and arm 31 thus accomplish this result, that after the series of selecting impulses have been received, and the brush 24 has been brought on to the selected contact on the segment 13 the selected operative circuit is closed, and also the way is prepared for a release impulse when received, to operate the magnet 27.

When the prolonged release impulse is received the sluggish magnet 27 is energized. The effect of this is to withdraw the detent pawl which holds the ratchet wheel in the position into which it has been advanced, and to separate the feed and chute pawls 23, 23^a, Fig. 6 from the ratchet wheel. The brush 24 consequently returns to the neutral position on the sector containing the contacts. The magnet 27 also releases the arm 31, which has been detained after making three fourths of a revolution and allows it to complete the revolution.

The return of the brush over contacts on the sector which were passed on the way to the particular contact selected, does not effect the closing of the operative circuits wired to those contacts, for two reasons. In the first place, as already explained, there is a master contact governing all the operative circuits, which is closed only when the arm 31 has made three fourths of a revolution. The release magnet releases the commutator 17 as well as the ratchet wheel 21, and the arm 31 in advancing locates the operative circuits. This movement is however a governed one, as the commutator is driven at a definite speed through its friction clutch, whereas the return of the brush 24 is very rapid being due directly to the return spring of the ratchet wheel 21. As an additional safeguard therefore against the closing of a non-selected circuit, a pair of contact springs 30 in the common supply circuit to the operative circuits is opened when the magnet 27 is energized.

By the time the sluggish magnet 27 has released its armature, the movement of the commutator has restored the magnet 16 to the control of the main relay 4 and cut the magnet 27 out of the circuit.

The complete apparatus is very light and may be conveniently contained in a glass-covered box for convenience of observation. This may be about 2 feet long by 9 inches wide, and its weight is about 7 lbs.

Great care is necessary for proper enclosing of the contacts and wires. The metal shield 33 is for shielding the motor in order that any sparking may not operate any part of the gear.

It will be observed that this apparatus can be treated relatively roughly, and it is a perfectly straightforward piece of mechanism to construct.

It will also be noticed that in this apparatus signals are only sent when initiating an operation and when effecting a return to neutral.

I may point out that the coherer when prepared in the manner mentioned is capable of tuning to some extent, but, more important than this, it is operated well only by a sudden rush of current, so that the sending of ordinary wireless signals does not affect it. It is necessary to use only a small condenser discharge, with the actual gap spark in the nature of an arc across the gap of the sending apparatus. This prevents practically every ordinary signal from reaching the coherer, and at the same time the signals sent would not interfere to any extent whatsoever with ordinary wireless operations. In addition to this, it is clear that the signals must be sent of a definite length as well as time interval to allow the coherer and magnets to operate against the relay and magnet springs, and at the same time unless the signals are completed within a definite period the commutator 17 will have revolved past the fibre section 17^c, cutting out the pecker magnet 16, energizing the magnet 27 and thus returning the brush to normal. If therefore the main current has been directed through an operative mechanism and unintentionally a wireless signal were picked up, the signal if of sufficient duration to operate the sluggish magnet 27 would automatically return the operative mechanism to normal, but would not effect any other operation.

A simple device may be fitted so that if the main circuit is not closed after the arm 31 reaches its stop, the whole mechanism is returned to normal.

Other lagging devices than the slipping clutch drive of the commutator and decoherer may be employed and the signals sent may be of a varied nature such as long and short alternately, or they may be of widely different strengths, each strength operating a coherer of slightly different type within short periods of each other. The coherer may be duplicated for security if desired.

Neither is the use of this apparatus confined to a coherer receiver, but the signals must in all cases, to be effective, be sent at the same rate at which the receiving gear will operate.

It will be observed that there is nothing to prevent more than one contact being wired to the same operative mechanism if desired. In some cases such as when controlling the rudder of an aeroplane, it is desirable to keep the contact on to one of the sectors for a short period only, and then to return to the same sectors without delay. This may conveniently be done by means of an ordinary clutch controlling the rudder operating gear on the aeroplane from the engine, this clutch being operated by a separate contact on the sector which would be put into operation before the other contacts, when this particular motion is required. It is also desirable when the apparatus cannot be easily observed to be able to return the brush 24 to normal even if it be not in sequence with the other operations and this is done most conveniently by having a longer contact to operate the return so that magnet 27 operates it at a different speed to magnet 16 by for example varying the rate of saturation. This renders interference still more difficult and is found in practice to be exceedingly successful.

At the same time should it be required to operate the return to neutral by a master signal of for example a definite length or duration, I accomplish this by mounting the three-armed pieces 6 on a threaded portion of the shaft in such a manner that if it is allowed to slip round long enough by the coherer remaining cohered, it will travel up the screw and make another contact which throws out all the other magnets and returns the brush to normal on the sector.

In the light of the description furnished above, the circuit diagram shown in Fig. 7 will be readily followed. The battery B^1 is in circuit with the coherer 1 Fig. 7 and coherer relay 2. A represents the aerial and E the "earth". The coherer relay closes a circuit from the battery B^2 through the variable resistances R^1 R^2 and the main relay 4. The contacts 15 of the main relay supply current from the battery B^3 through resistance R^2 to commutator 17 and magnet 16, returning through resistance R^3. The decoherer magnet 11^a receives current from the battery B^5 through the contacts 11 which as explained above are closed for a certain period during the revolution of the arms 10 Fig. 1. A battery B^4 supplies the motor M. The lead from the contacts 15 is cut off from the magnet 16 and connected with the release magnet 27 after the commutator has turned through three fourths of a revolution. The brush 24 receives its supply of current for the operative circuits through the contacts 30, which are broken when the release magnet is energized, and (in series with those contacts) through the contacts 24^a which are closed by the arm 31 Fig. 1 when it has made three fourths of a revolution. The leads 13^b pass to the operative circuits.

In conclusion I will direct special attention to the following features which are of importance in rendering my apparatus effectively selective, and which renders difficult any interference by impulses not proceeding from the controlling station.

(1) An incoming impulse to be effective must be of sufficient strength and duration to cause the special coherer employed to become conductive.

(2) Decoherence begins at a predetermined time after the receipt of the impulse. and is continued for a definite period, these periods being determined by the movements of the arm 10. Fig. 1. A second impulse received before or during the period of decoherence would thus be ineffective. That is to say, the time interval between the signals must exceed a certain value.

(3) The time interval between the impulses must also not be too great, for all impulses, to be effective. must be received while the segment 17^a Fig. 5 of commutator is passing beneath the commutator brushes. An impulse received after the commutator has made three fourths of a revolution will either produce no effect at all, or if sufficiently prolonged will energise the release magnet 27 Fig. 1. It will therefore do no more than return the controlled mechanism to neutral, and will not bring about the closing of any other operative circuit.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A mechanism or switch by means of which one of a series of contacts can be closed to the exclusion of others so as to bring about a particular selected operation, characterised in that the selection takes place without regard to the strength, direction, or wave-length of the incoming electric current or radio-oscillation, but depends upon the number of incoming impulses and their duration and time intervals.

2. For the purposes referred to in Claim 1, an apparatus comprising in combination a coherer, a coherer relay, a main relay, a decoherer under control of a time - switch, a commutator with governed motion for associating the main relay contacts firstly with an electromagnet for stepping round the selector brush, and secondly with a release magnet, operative circuits wired to contacts traversed by the selector brush, and contacts for maintaining the operative circuits open until the commutator has made a definite prearranged movement.

3. In apparatus as claimed in Claim 2, contacts under control of the release magnet for breaking all operative circuits when the release magnet is energized.

4. Apparatus for the purposes referred to in Claim 1, provided with timed switches or commutators so arranged that the desired operation cannot be brought about if the time interval between the beginning of one impulse and the beginning of the next has less than a prearranged value.

5. Apparatus for the purposes referred to in Claim 1, provided with timed switches or commutators so arranged that the desired operation cannot be brought about if the total duration of all the impulses together with the intervals between them exceeds a prearranged value.

6. Apparatus as claimed in Claim 1 so arranged that if the timing of switches in the receiving apparatus is not in proper correspondence with the timing of the incoming impulses, either the selec-

tion mechanism will fail to operate or it will return to the same position as before energy was transmitted.

7. Apparatus of the kind claimed in Claim 1, or more particularly in Claim 2, in which release is effected only by a prolonged impulse.

8. Apparatus constructed and operating substantially as hereinbefore described.

Dated this 10th day of May, 1917.

A. M. LOW.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1926.

[This Drawing is a reproduction of the Original on a reduced scale]

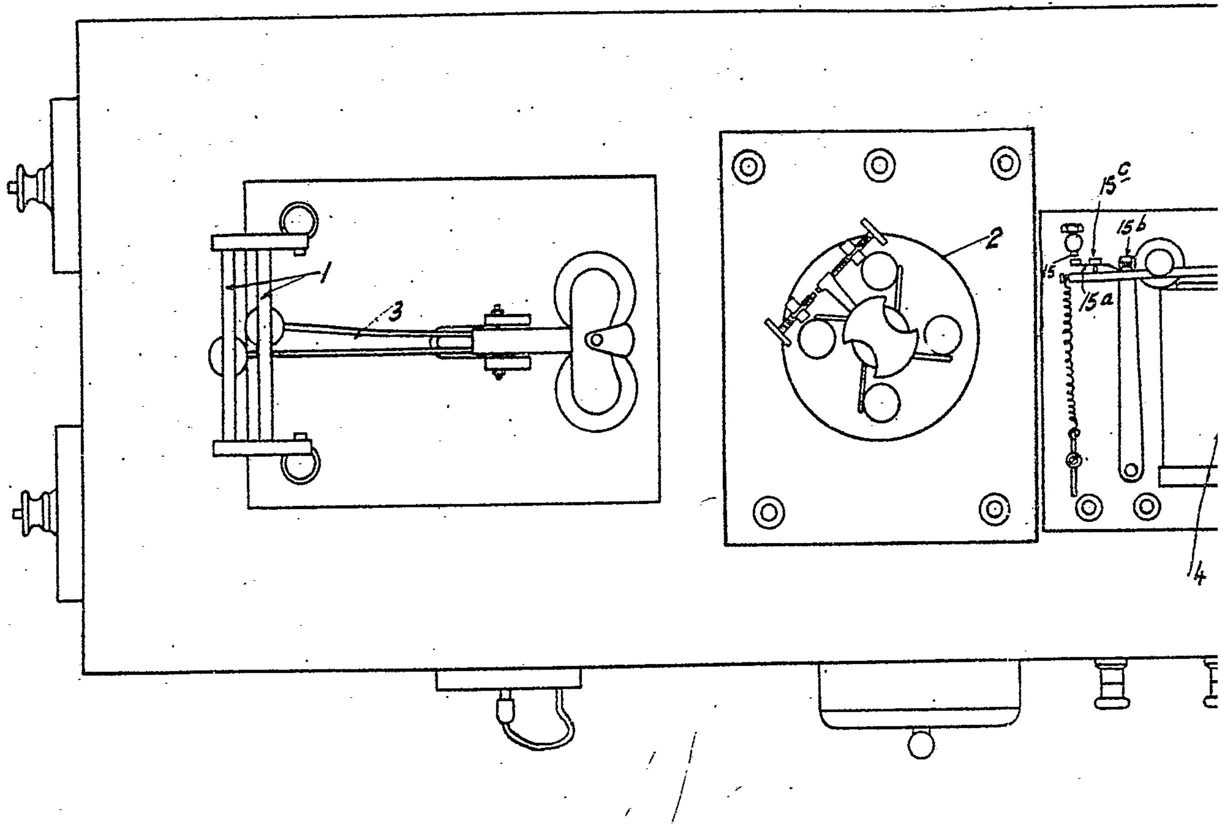

FIG 1.

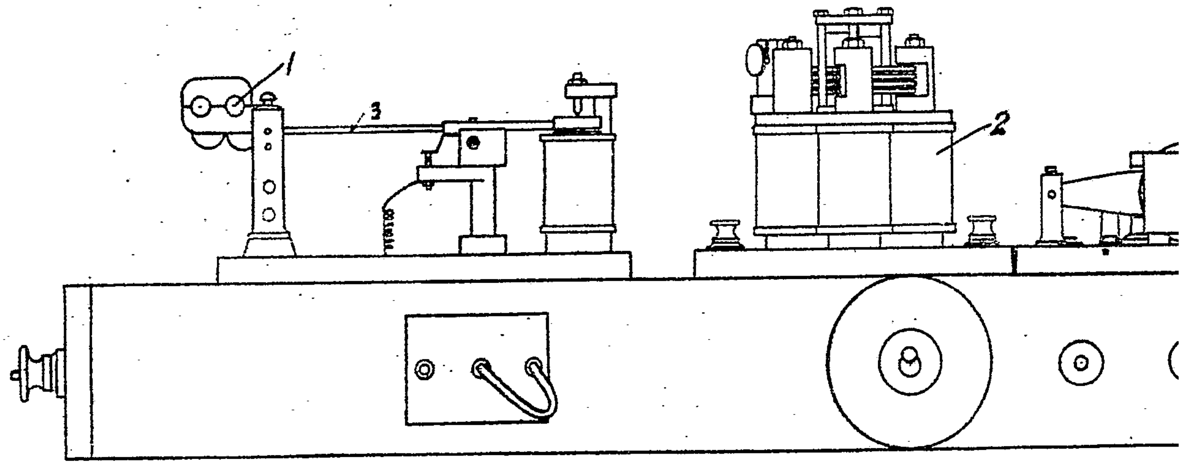

FIG 2.

5 SHEETS
SHEET 1

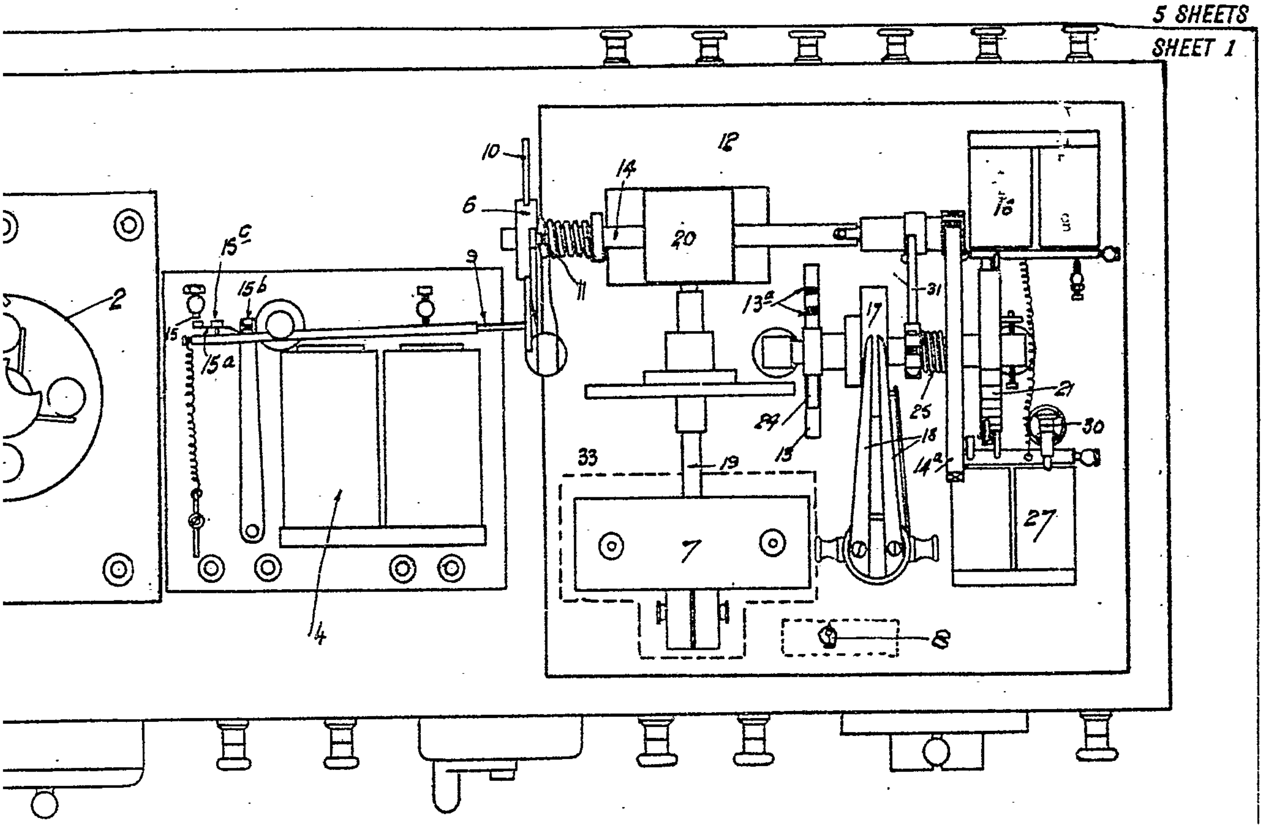

FIG 1.

SHEET 2

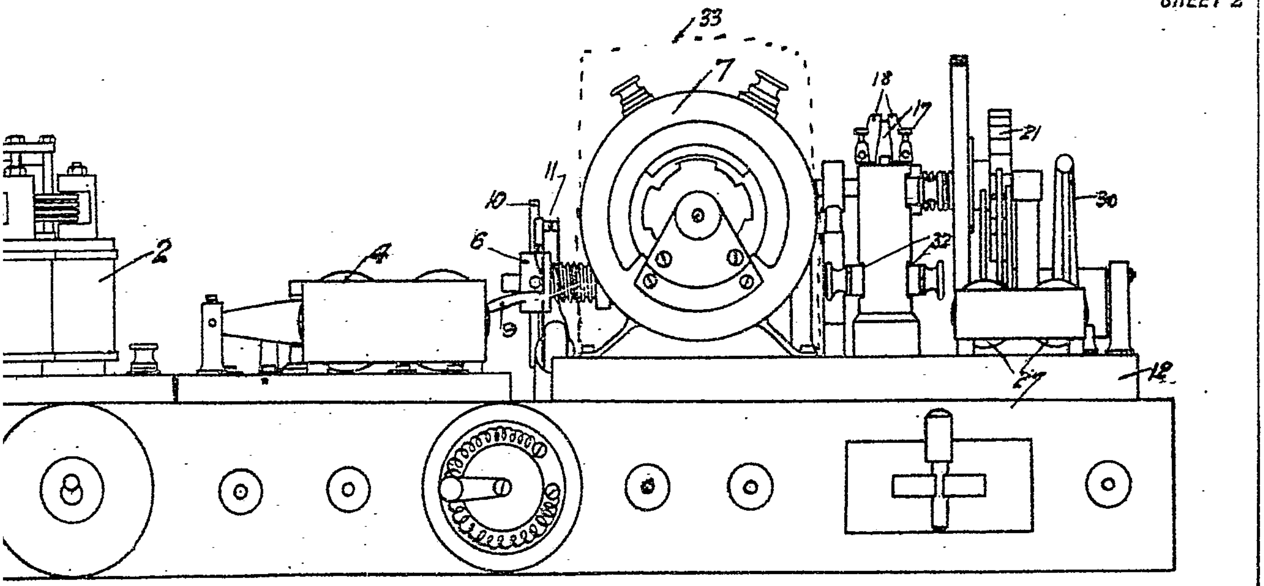

FIG 2.

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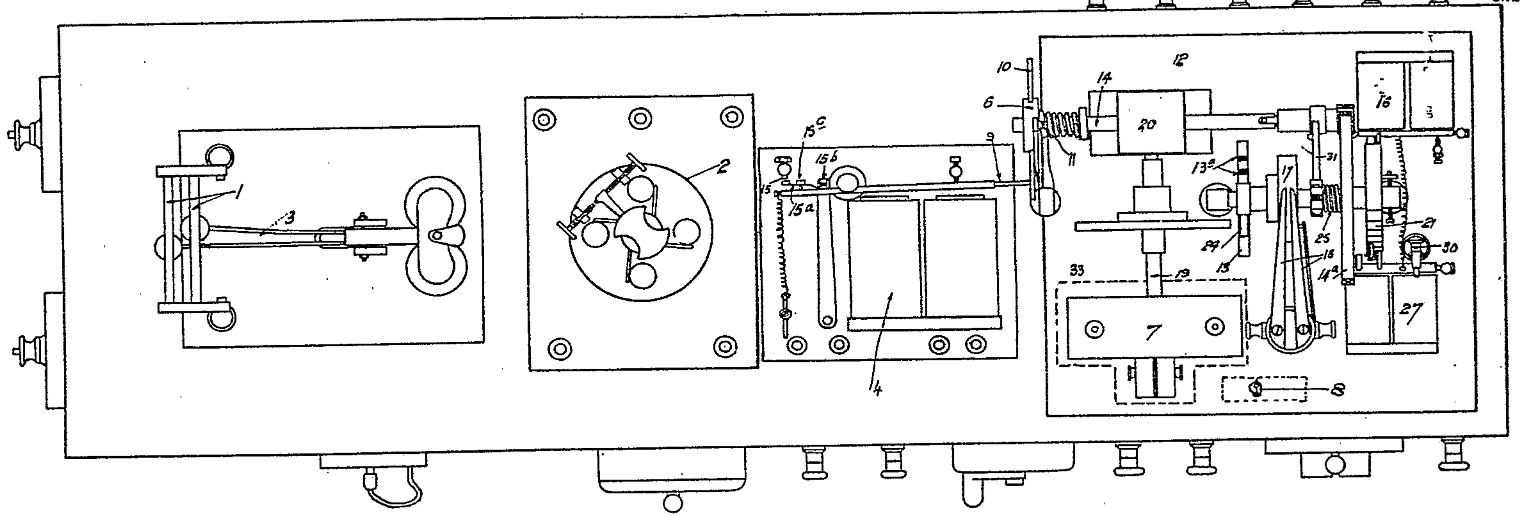

FIG 1.

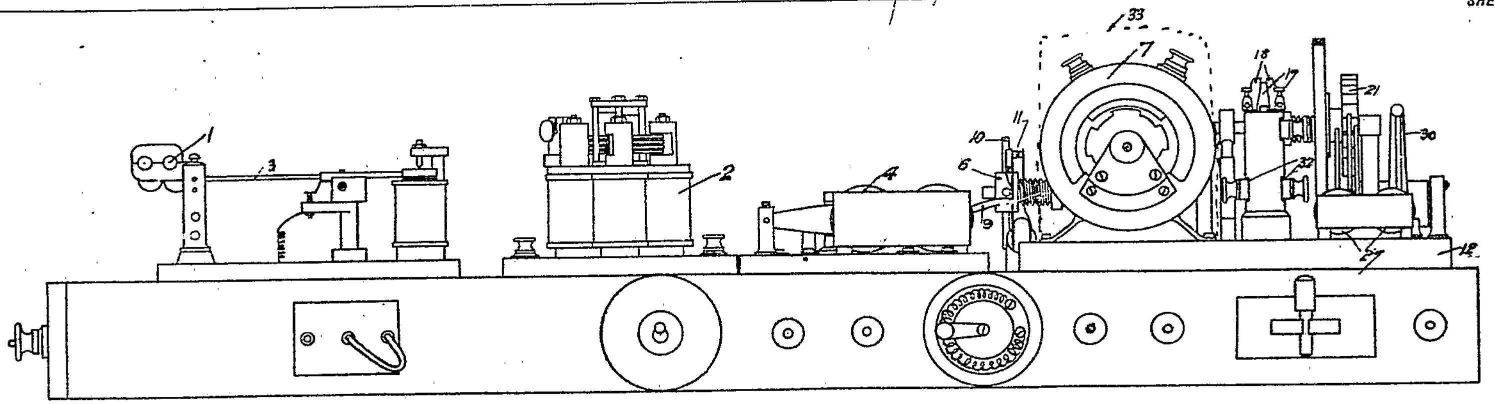

FIG 2.

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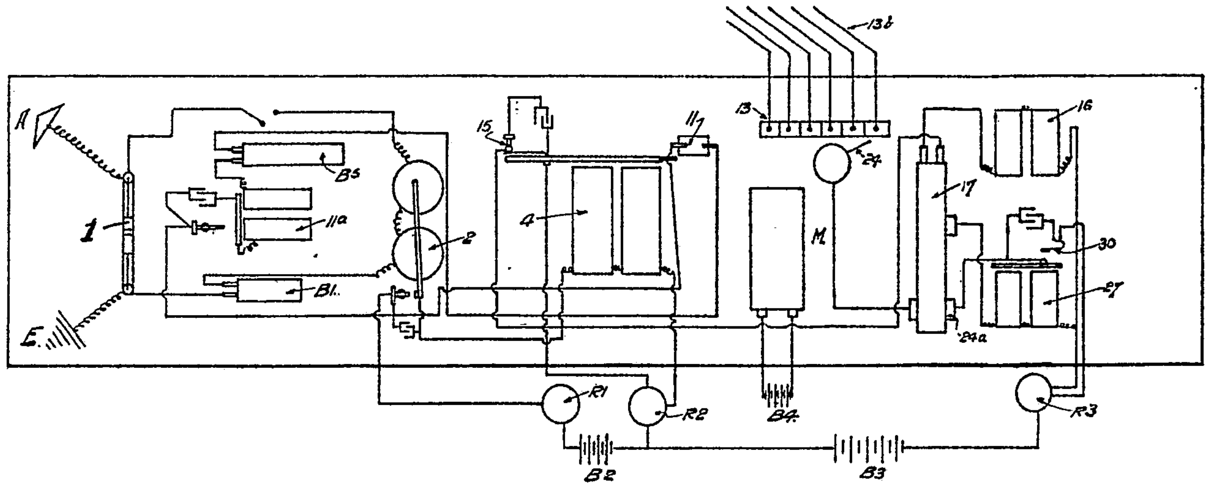


FIG 7

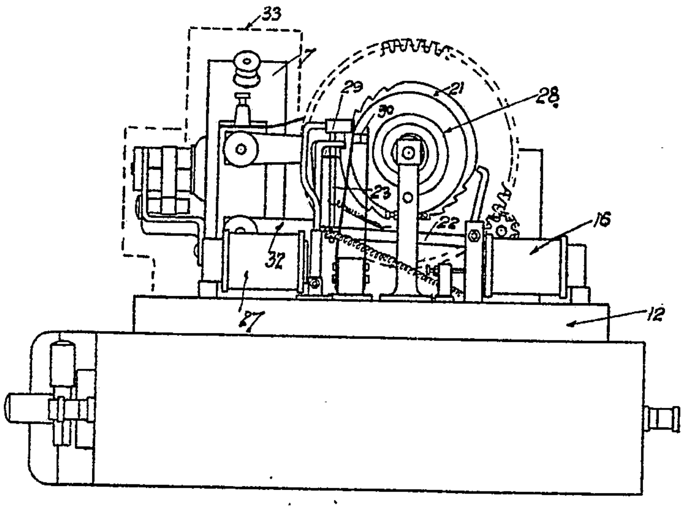
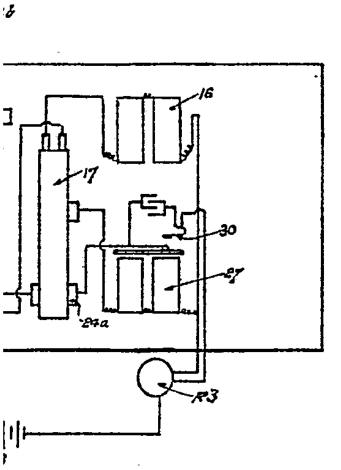


FIG. 3

5 SHEETS

SHEET 5



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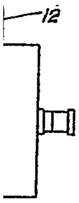

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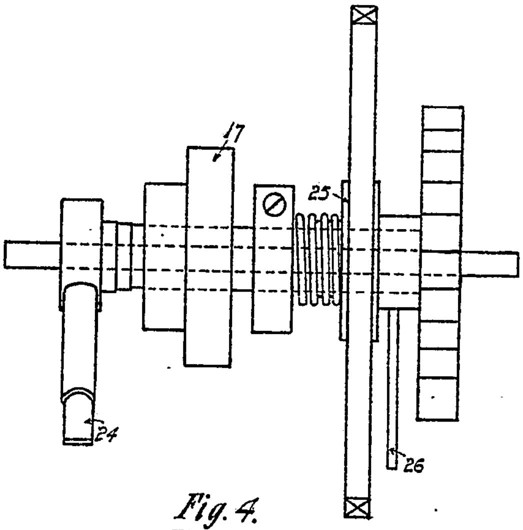

Fig. 4.

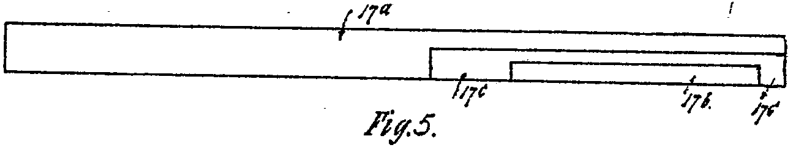

Fig. 5.

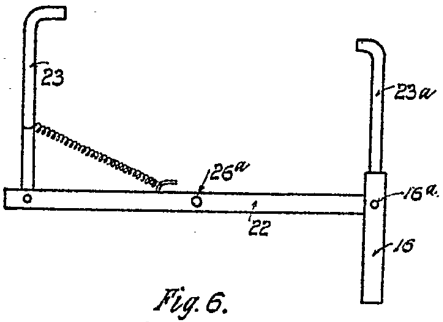

Fig. 6.

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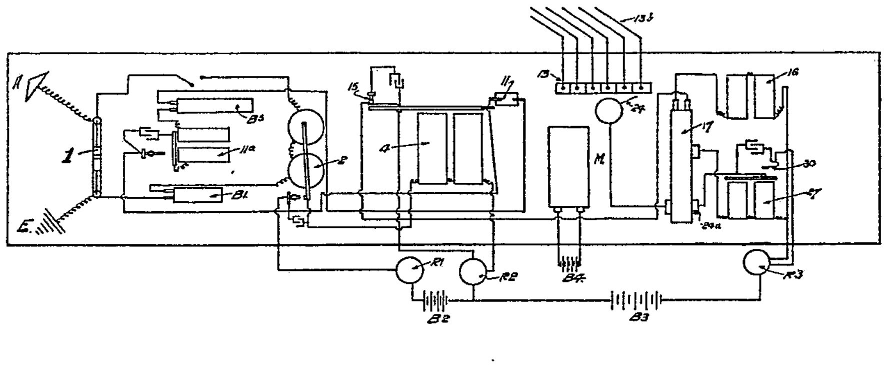

Fig 7

SHEET 3

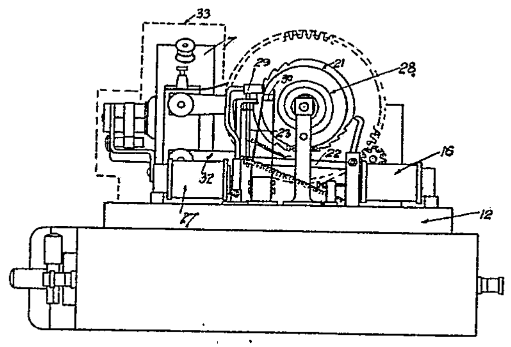

Fig. 3

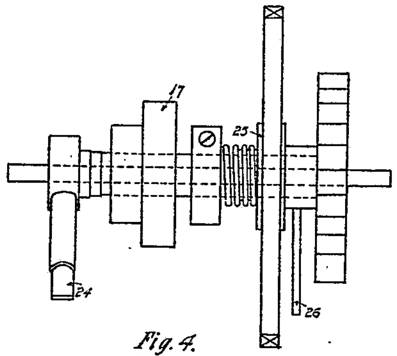

Fig. 4.

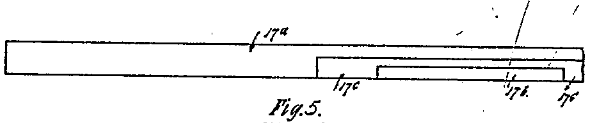

Fig. 5.

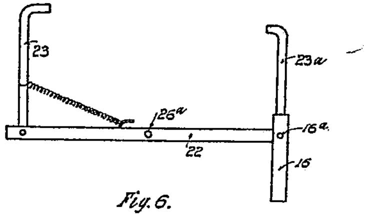

Fig. 6.

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